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IDENTIFIERS	*Insulation; Oklahoma

ABSTRACT

This module on introductory insulation is one of a series of modules designed to teach basic skills necessary for entry-level employment in this field. The instructor's guide contains three instructional units that cover the following topics: (1) insulation materials; (2) insulation tools; and (3) insulation layout and basic skills. Each instructional unit follows a standard format that includes some or all of these eight basic components: performance objectives, suggested activities for the instructor, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests and assignment sheets. All of the unit components focus on measurable and observable learning outcomes and are designed for use in more than one lesson or class period. A competency profile for evaluating trainees is included. (KC)

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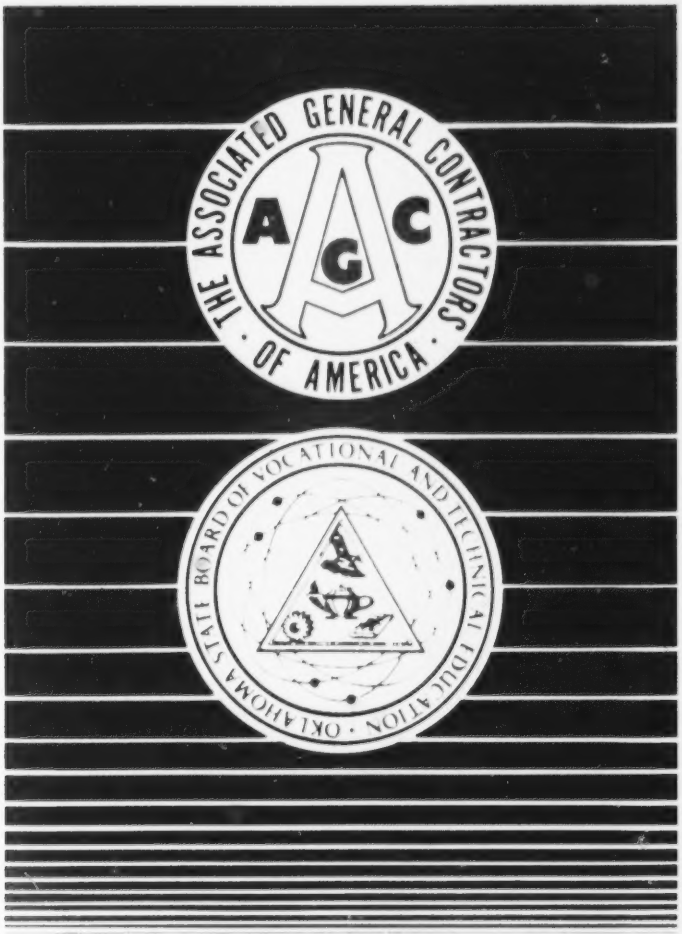

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Introduction to Insulation

CE032333

Introduction to Construction Series

instructor edition

89-006099

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INTRODUCTION TO INSULATION

Developed as a Cooperative Project by
The Associated General Contractors of America
William K. Healy, Chairman, Manpower and Training Committee
and
Oklahoma State Board of Vocational and Technical Education
John Folks, Chairman
Roy Peters, Jr., Director

89-006099

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INTRODUCTION TO INSULATION
COMPETENCY PROFILE

Student: _____ Soc. Sec. No.: ___ ___ _____
Last First MI

_____ Grade 9 10 11 12 Adult _____
PROGRAM SCHOOL

_____ _____ _____
INSTRUCTOR SCHOOL ADDRESS PHONE

_____ _____ _____
STUDENT'S HOME ADDRESS DATE OF BIRTH PHONE

_____

_____ _____ _____
STUDENT'S EMPLOYER ADDRESS PHONE

_____

_____ _____
CONTACT IN CASE OF EMERGENCY PHONE

_____
ADDRESS

_____
OR

_____ _____
ADDRESS PHONE

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DURATION OF EMPLOYMENT	JOB TITLE	EMPLOYER	SUPERVISOR'S NAME	ADDRESS OF EMPLOYER	PHONE

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SPECIFIC JOB COMPETENCIES

Directions: Evaluate the trainee using the rating scale below and check the appropriate number to indicate the degree of competency achieved. The numerical ratings of 4, 3, 2, 1, and 0 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on level of student performance for each of the tasks listed below. The written test score line is provided for optional teacher use. It may not be applicable in all cases. "NA" is an appropriate entry in such instances.

Rating Scale:
4 — Skilled — can perform independently with no additional training.
3 — Moderately Skilled — has performed independently during training program, limited additional training may be required.
2 — Limited Practice — has practiced during training program, additional training is required to develop skill.
1 — Exposure Only — general information provided with no practice time, close supervision needed and additional training required.
0 — No Exposure — no information or practice provided during training program, complete training required.

4 3 2 1 0
☐☐☐☐☐ *Insulation Materials*
☐☐☐☐☐ 1. _____

WRITTEN TEST SCORE _____

4 3 2 1 0
☐☐☐☐☐ *Insulation Tools*
☐☐☐☐☐ 1. _____

WRITTEN TEST SCORE _____

4 3 2 1 0
☐☐☐☐☐ *Insulation Layout and Basic Skills*
☐☐☐☐☐ 1. Install vapor barrier and insulation for a concrete slab
☐☐☐☐☐ 2. Install blanket insulation in walls
☐☐☐☐☐ 3. _____

WRITTEN TEST SCORE _____

Use of This Document

This document can be used to record information about the student and the skills mastered by the student. This information is useful in documenting student progress during the training program and to provide information about the student's qualifications to potential employers and for entry into advanced training programs. Instructors using AGC-CIMC instructional materials are authorized to reproduce this document as required for use in their training programs.

INTRODUCTION TO INSULATION

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FOREWORD

In 1985, The Associated General Contractors of America (AGC) met with representatives of the Oklahoma Curriculum and Instructional Materials Center (CIMC) to discuss the possibilities of developing, as a cooperative project, a course of instruction designed for training individuals who choose to seriously explore careers in construction.

This publication is the result of those original discussions and close coordination among general contractors and vocational educators. This series represents a conscious effort to coordinate the practical experience of personnel in the construction industry with the best instructional methods of those in the field of vocational education.

Although this series reflects a systematic approach to instructional materials development and the latest in educational technology innovations, the information in *Introduction to Insulation* should be adapted and modified to coincide with local conditions.

Dr. Roy Peters, Jr., Director
Oklahoma State Department of
Vocational and Technical Education

William K. Healy, Chairman
Manpower and Training Committee
The Associated General Contractors
of America

PREFACE

For many years The Associated General Contractors of America (AGC) has recognized the need for providing quality competency-based instructional materials for the construction industry. AGC and the Oklahoma State Department of Vocational and Technical Education have met this challenge by providing nationally recognized curriculum and services since 1972. In 1986 AGC and Oklahoma's Curriculum and Instructional Materials Center (CIMC) determined a significant need for a series that would address training needs of open shop contractors, preapprenticeship programs, multi-craft high school programs, technology education programs, CVET, and cooperative education programs. The Introduction to Construction Series was designed with the flexible training requirements of these groups in mind.

The Introduction to Construction Series begins with *Fundamentals of Construction* and progresses to twelve spin-off specialty publications. *Fundamentals of Construction* covers basic knowledge necessary for all individuals in construction. Each specialty area covers basic skills necessary for entry-level employment. Both vocational education and the construction industry offer more advanced courses in each specialty area and should be considered by individuals wishing to establish careers in the industry. Competency profiles (provided in the teacher edition) for the Introduction to Construction Series articulate with several more advanced AGC publications as well as publications developed by the Mid-America Vocational Curriculum Consortium (MAVCC).

Publications in this series include:

- Introduction to Bricklaying
- Introduction to Carpentry
- Introduction to Concrete Masonry
- Introduction to Ironwork
- Introduction to Electricity
- Introduction to Plumbing
- Introduction to Heating, Ventilation,
- and Air Conditioning
- Introduction to Sheet Metal
- Introduction to Roofing
- Introduction to Drywall
- Introduction to Insulation
- Introduction to Welding

Instructional Units

Introduction to Insulation contains one section and three instructional units. A standard format was established in 1970 for development of instructional materials for all Oklahoma vocational teachers. This format includes eight basic components that form a unit of instruction: performance objectives, suggested activities for the instructor, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to tests and assignment sheets. Depending on specific objectives, there may or may not be transparency masters, assignment sheets, and job sheets included in the unit of instruction.

All of the unit components "zero in" on measurable and observable learning outcomes. Instructors are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the instructor will help him or her determine the following

- Amount of material that can be covered in each class period
- Skills that must be demonstrated
  - Supplies and equipment needed
  - Amount of practice needed
  - Amount of class time needed for demonstrations
- Supplementary materials, such as pamphlets and filmstrips, that must be ordered
- Resource people who must be contacted

Performance Objectives (white pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching/learning process, it is important that instructors and students have a common understanding of the intent of the objectives.

The objective sheet should be given to students and referred to throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Prepare for each unit by deciding how each objective can best be taught.

The objective sheet may also be used as a quick pretest to determine students' prior knowledge and to determine whether further study or activities are necessary. Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When changes in objectives are made, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Suggested Activities (pink pages)

Suggested activities are included only in teacher materials. The suggested activities pages include an outline of the unit contents and an instructor's guide designed to assist teachers in planning their presentation of the unit. The instructor's guide provides suggestions for delivery and/or presentation during the instructional process. Read the suggested activities before teaching the units so that supplemental materials can be obtained, audiovisual materials prepared, and outside resources contacted. Duties of the teacher will vary according to the particular unit.

The references that are listed in the suggested activities are ones used in the development of each unit. They should be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

The suggested activities section of the unit also includes supplements and transparency masters. Each of these components provides information in a special way. Supplements may consist of motivational materials, review or practice materials such as crossword puzzles and self-tests, or charts and reference materials. Supplements are designed to be copied and distributed to individual class members or to the class as a whole. Suggestions for their use are included in the instructor's guide. Transparencies direct the class' attention to the topic of discussion. Transparencies may present new information, or they may reinforce information presented in the information sheet. They are particularly effective when identification or analysis is necessary. Order transparencies from the Curriculum and Instructional Materials Center, or make transparencies and place them in the notebook where they will be immediately available for use.

Information Sheet (green pages)

The information sheet provides "must know" content essential for meeting the cognitive (knowledge level) objectives of the unit. The information is written in a topical-outline form and is keyed to the specific objectives.

Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. The information sheet may also be used for coordination activities and advisory committees.

Students should read the information sheet before the information is discussed in class. Space provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide motivation for each unit.

Assignment Sheets (brown pages)

Assignment sheets give students a chance at problem solving, self-assessment, and/or practical experience. They assist students in the application of knowledges that are necessary prerequistes to skill development. Assignment sheets may be given to the student for completion in class or may be used for homework assignments. Answer sheets are provided when appropriate and can be used by the student and/or teacher for checking student progress. The scores of those assignment sheets listed in the specific objectives should be averaged with the unit test score, as the skills addressed in these assignment sheets are considered necessary in meeting the unit objective.

Job Sheets (blue pages)

Job sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure needed to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

The teacher should demonstrate to students the procedures outlined in each job sheet. Furthermore, the teacher needs to localize the job sheet according to the equipment and supplies available in the local lab or shop situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Job sheet performance should be evaluated by the instructor and averaged with the unit test score, as the skills addressed in the job sheets are considered necessary in meeting the unit objective.

Tests (White pages)

Tests are included only in teacher materials. The test provides criterion-referenced evaluation of every objective listed in the unit of instruction. It is crucial to note that both paper/pencil and performance objectives must be evaluated.

It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of questions from the units covered may be used for final tests at the end of each term if desired. If objectives have been added, deleted, or modified, be sure to make the changes on the test.

The acceptable response on a unit test, 80 percent in most units, may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each question. The final unit grade should be obtained by using the paper/pencil score and evaluations of student demonstrations of the desired skills.

Answers to Test and Assignment Sheets (pink pages)

Answers to test and assignment sheets are components designed to assist the teacher in evaluation of student performances.

Page Numbering

Each publication from the Curriculum and Instructional Materials Center (CIMC) is assigned a specific abbreviation. For example, *Introduction to Insulation* has been abbreviated ITI. The units are then numbered consecutively within each section. An example of a page number is ITI-1. Since CIMC publications are loose leaf, this sytem of page numbering was adopted so that pages from different manuals would not get mixed up.

Methods of Disseminating Material

For best results, provide student materials for each student. Student materials contain everything but the test, supplements, answers to assignment sheets, and suggested activities.

Teaching Methods

It is a challenge to keep students motivated. Supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

Competency Profiles

Competency profiles are folders used to document student performances. The profile contains a list of the specific job competencies that a student should achieve prior to leaving the training program. A competency profile master is provided in the instructor edition of each publication. Duplicate the profile and distribute to students as required.

Other AGC Publications: AGC updates curriculum products on a continuing basis. For a free catalog describing other AGC products, call the AGC National office at 1-202-393-2040.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected pages and to indicate the correction on the copy. You can then mail the information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, it is important that you notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Curriculum Development Coordinator
Curriculum and Instructional Materials Center
Oklahoma State Department of Vocational and Technical Education
1500 W. Seventh Avenue
Stillwater, Oklahoma 74074-4364

INSULATION MATERIALS
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to explain the basic functions of insulation, the benefits of using insulation, general classifications of insulation and the types of insulation used in construction. The student will show this knowledge by completing the unit test with a minimum score of 80 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with insulation to their correct definitions.
2. Explain briefly the functions of the two basic kinds of insulation used in construction.
3. Select from a list benefits of using insulation in a structure.
4. List types of insulation commonly used in construction.
5. Name general classifications of insulation materials.
6. Name types of materials used for vapor barriers.

INSULATION MATERIALS
UNIT I

SUGGESTED ACTIVITIES

I. Unit contents

A. Objective sheet

B. Suggested activities

C. Supplements

1. Supplement #1 — Thermal Insulation Materials

2. Supplement #2 — R-Values Per Inch for Various Types of Insulation and Construction Materials

D. Information sheet

E. Test

F. Answers to test

II. Instructor's guide

A. Review unit and plan presentation.

B. Obtain materials to supplement unit.

1. Literature and advertisements from insulation companies or public utilities

2. Ear plugs, thermometers, and a safe heat source

3. Model or cross-section of wall showing insulation

4. Plans specifying insulation

5. Competency profiles

(NOTE: A master of the competency profile for this book is provided at the front of the instructor edition. You may duplicate the profile and distribute it to students as needed.)

C. Introduce unit to students.

- Demonstrate the effectiveness of insulation in sound and heat-transfer reduction with simple examples such as ear plugs, thermometer near a heat source compared to a thermometer protected by thermal insulation, etc.

- Discuss other common uses of insulation, such as in water heaters, refrigerators, stoves, and ovens and under hoods of cars. Emphasize that in a lot of cases these types of materials insulate against sound as well as heat or cold weather.

SUGGESTED ACTIVITIES

- Display literature and advertisements from insulation companies or public utilities promoting the use of insulation.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information sheet.

G. Discuss information sheet.

1. Use Information sheet, Section I, to discuss terms and definitions associated with insulation materials.

   - Point out the importance of defining terms for common understanding.
   - Show the class a model or wall cross-section to clarify definitions.
   - Display an iced drink in a metal container to demonstrate condensation.
   - Show the class samples of structural members that have developed wood rot from excessive moisture.

2. Use Information Sheet, Section II, to discuss the functions of the two basic types of insulation.

   - Exhibit samples of both thermal and acoustical insulation.
   - Provide the class with plans specifying each type of insulation and discuss their applications.

3. Use Information Sheet, Section III, to discuss benefits of using insulation in a structure.

   - Ask the students to read articles or literature from insulation manufacturers and distributors to expand the discussion.
   - Demonstrate the benefits of insulation listed in the information sheet.

4. Use Information Sheet, Section IV, to discuss types of insulation commonly used in construction.

   - Show the class samples of each type of insulation discussed in this section of the information sheet.
   - Invite an insulation installer to discuss the procedures involved in installing each type of insulation, the advantages and disadvantages of each type of insulation, and the types of insulation used in your area, especially any not covered in the information sheet.

SUGGESTED ACTIVITIES

5. Use Information Sheet, Section V, to discuss general classifications of insulation materials.

   - Show the class Supplement #1 and samples of the various insulation materials discussed in this section of the information sheet.

   - Point out that all materials have some insulating value, including dead air space, and emphasize the differences in resistive values by showing the class Supplement #2.

6. Use Information Sheet, Section VI, to discuss materials used for vapor barriers.

   - Provide students with samples of each material discussed in this section of the information sheet.

H. Give test.

I. Critique test and discuss in class.

J. Reteach and retest as necessary.

K. Complete appropriate sections of competency profiles.

III. Unit reference

Hendrix, Laborn J. "Bud." *Commerical Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1986.

INSULATION MATERIALS
UNIT I

SUPPLEMENT #1 — THERMAL INSULATION MATERIALS

Classification	Material	Comments
Mineral	Rock Slag Glass Vermiculite	Rock and slag are used to produce "wool" by grinding and melting the materials and blowing them into a fine mass.
Vegetable (natural)	Wood Sugar cane Corn stalks Cotton Cork Redwood bark Sawdust or shavings	Many vegetable products are processed and formed into various shapes, including blankets and rigid boards.
Plastic	Polystyrene Rubber	
Metal	Foil Tin plate Copper Aluminum	Metallic insulating materials are generally applied to rigid boards or papers and are used primarily for their reflective value.

INSULATION MATERIALS
UNIT I

SUPPLEMENT #2 — R-VALUES PER INCH FOR VARIOUS TYPES OF INSULATION AND CONSTRUCTION MATERIALS

Material	R-Value per Inch
Polyisocyanurate	7.2
Extruded styrene	5.2
Fiberglass board	4.7
Expanded polystyrene	4.0
Cellulose	3.8
Corkboard	3.7
Fiberglass (batts)	3.2
Rock wool	3.0
Perlite (expanded)	3.1
Fiberglass loose fill (premium grade)	2.7
Fiberglass loose fill (standard grade)	2.2
Cellular glass	2.6
Vermiculite (loose fill)	2.0
Fir, pine	1.3
Concrete block	1.1
Glass	0.9
Brick	0.2
Cement plaster	0.2

(NOTE: Fiberglass loose fill has a wide range of R/inch values depending on brands.)

SUPPLEMENT #2

(NOTE: K-Factor—The amount of heat (in Btu's) transferred in one hour through 1 square foot of a given material that is 1 inch thick and has a temperature difference between its surfaces of 1 degree Fahrenheit (F). It is also called the coefficient of thermal conductivity.

R-Value—Represents the resistivity or resistance which is the reciprocal of conductivity or conductance. A good insulation material will have a high R-Value.

U-Value—Represents the total heat transmission (in Btu's) per square foot, per hour with 1 degree temperature difference for a structure which may consist of several materials or spaces. A good insulation material will have a low U-Value.)

INSULATION MATERIALS
UNIT I

INFORMATION SHEET

I. Terms and definitions associated with insulation materials

A. **Insulation** — Material used in walls, ceilings, and floors to retard the passage of heat, cold, and sound

B. **Reflective insulation** — Metal-surfaced insulating material exposed to an air space to reduce heat radiation across the air space

C. **Perimeter insulation** — Insulating material installed at foundation and floor slab around the outside boundaries of the structure

D. **Condensation** — Process by which vapor becomes liquid

E. **Moisture penetration** — Process by which moisture moves into a structure

F. **Vapor barrier** — Material that prevents the passage of moisture or vapor into or through structural elements

II. Functions of the two basic kinds of insulation used in construction

A. **Thermal insulation** — Retards the transfer of heat from inside a structure to the outside and from the outside into the structure

B. **Acoustical insulation** — Retards the passage of sound waves from the outside into a structure or from one room to another within the structure

III. Benefits of using insulation in a structure

A. Prevents rapid temperature changes

B. Reduces fuel consumption

C. Retards or resists the spread of fire

D. Prevents condensation

E. Provides a sound barrier from within and without

F. Helps absorb echoes

G. Reduces the potential for wind-uplift damage to a roof system

INFORMATION SHEET

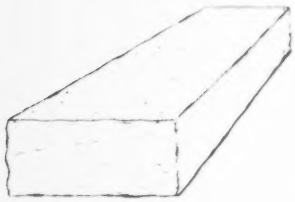
IV. Types of insulation commonly used in commercial construction (Figures 1-10)

(NOTE: There are many types of insulation other than those listed below. Other types of insulation include lightweight aggregates such as vermiculite, perlite, blast furnace slag, burned clay products, and cinders. Aggregates are commonly used in plaster and concrete to improve the insulating qualities of these materials.)

A. Flexible batt insulation

EXAMPLE:

FIGURE 1



B. Flexible blanket insulation

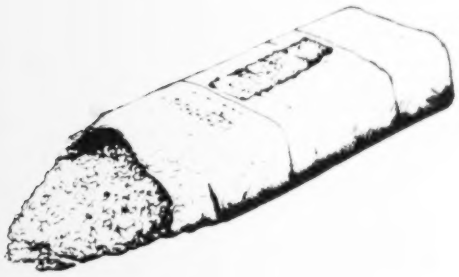
EXAMPLE:

FIGURE 2

C. Loose-fill insulation

EXAMPLE:

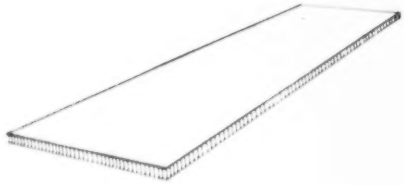
FIGURE 3



D. Rigid board insulation

EXAMPLE:

FIGURE 4

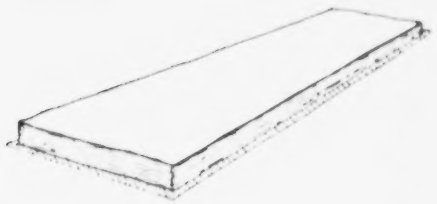


INFORMATION SHEET

E. Reflective insulation

EXAMPLE:

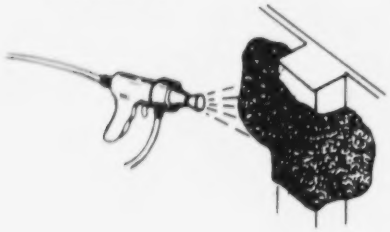
FIGURE 5



F. Adhesive-type insulation

EXAMPLE:

FIGURE 6



G. Corrugated-paper insulation

EXAMPLE:

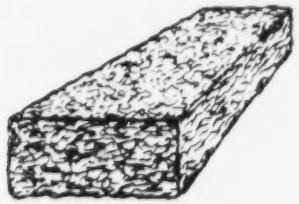
FIGURE 7

H. Friction-batt insulation

(NOTE: Friction-batt insulation is fiberglass insulation with a paper cover.)

EXAMPLE:

FIGURE 8



I. Foamed-plastic insulation

EXAMPLES:

FIGURE 9: Blown-in foamed-plastic insulation

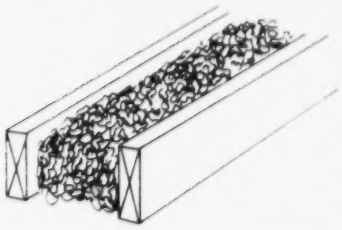
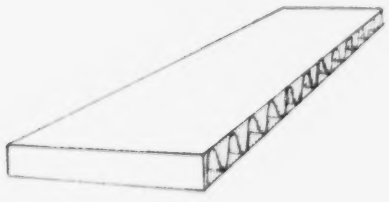


FIGURE 10: Rigid-board foamed-plastic insulation



INFORMATION SHEET

V. General classifications of insulation materials

A. Mineral

B. Vegetable (natural)

C. Plastic

D. Metal

VI. Types of materials used for vapor barriers

(NOTE: Many insulation materials and interior surface materials are backed with vapor barriers which, when installed properly, are usually sufficient to resist moisture penetration. The following materials are used as vapor barriers either alone or in combinations.)

A. Asphalt saturated felt (roll roofing)

B. Aluminum foil

C. Polyethylene film

D. Rosin sheathing

INSULATION MATERIALS
UNIT I

TEST

NAME _____ SCORE _____

1. Match terms associated with insulation to their correct definitions. Write the correct numbers in the blanks.

_____a. Process by which vapor becomes liquid	1. Insulation
_____b. Material used in walls, ceilings, and floors to retard the passage of heat, cold, and sound	2. Perimeter insulation
_____c. Process by which moisture moves into a structure	3. Condensation
_____d. Insulating material installed at foundation and floor slab around the outside boundaries of the structure	4. Vapor barrier
_____e. Metal-surfaced insulating material exposed to an air space to reduce heat radiation across the air space	5. Moisture penetration
_____f. Material that prevents the passage of moisture or vapor into or through structural elements	6. Reflective insulation

2. Explain briefly the functions of the two basic kinds of insulation used in construction.

   a. Thermal insulation — _____

   _____

   _____

   _____

   _____

   b. Acoustical insulation — _____

   _____

   _____

   _____

   _____

TEST

3. Select from the following list benefits of using insulation in a structure. Write an "X" in the blank before each correct answer.

   _____a. Provides a sound barrier from within and without

   _____b. Retards or resists the spread of fire

   _____c. Reduces fuel consumption

   _____d. Increases rapid temperature changes

   _____e. Helps absorb echoes

   _____f. Prevents condensation

   _____g. Reduces the potential for wind-uplift damage to a roof system

4. List four types of insulation commonly used in construction.

   a. _____

   b. _____

   c. _____

   d. _____

5. Name three general classifications of insulation materials.

   a. _____

   b. _____

   c. _____

6. Name three types of materials used for vapor barriers.

   a. _____

   b. _____

   c. _____

INSULATION MATERIALS
UNIT I

ANSWERS TO TEST

1. a. 3 c. 5 e. 6
   b. 1 d. 2 f. 4

2. Explanation should include the following.

   a. Thermal insulation—Retards the transfer of heat from inside a structure to the outside and from the outside into the structure
   b. Acoustical insulation—Retards the passage of sound waves from the outside into a structure or from one room to another within the structure

3. a, b, c, e, f, g

4. Answer should include any four of the following insulations.

   a. Flexible batt
   b. Flexible blanket
   c. Loose-fill
   d. Rigid board
   e. Reflective
   f. Adhesive-type
   g. Corrugated-paper
   h. Friction-batt
   i. Foamed-plastic

5. Answer should include any three of the following classifications.

   a. Mineral
   b. Vegetable (natural)
   c. Plastic
   d. Metal

6. Answer should include any three of the following types of materials.

   a. Asphalt saturated felt (roll roofing)
   b. Aluminum foil
   c. Polyethylene film
   d. Rosin sheathing

INSULATION TOOLS
UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to identify the tools used to install insulation and list rules for care and safe use of the tools. The student will show this knowledge by completing the unit test with a minimum score of 80 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with installation tools to their correct definitions.
2. State guidelines for care and safe use of hand tools, power tools, and equipment.
3. Identify tools and equipment used for insulation installation.
4. State safety rules pertaining to insulation and insulation equipment.

INSULATION TOOLS
UNIT II

SUGGESTED ACTIVITIES

I. Unit contents

A. Objective sheet

B. Suggested activities

C. Information sheet

D. Test

E. Answers to test

II. Instructor's guide

A. Review unit and plan presentation.

B. Obtain materials to supplement unit.

1. Tool and equipment catalogs from manufacturers

2. Samples of tools and equipment

3. Competency profiles

(NOTE: A master of the competency profile for this book is provided at the front of the instructor edition. You may duplicate the profile and distribute it to students as needed.)

C. Introduce unit to students.

- Have students review tool catalogs; discuss tools and point out the importance of buying good grades of tools. Tell students that quality, nct price, should be their main concern when purchasing tools.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information sheet.

G. Discuss information sheet.

1. Use Information Sheet, Section I, to discuss terms and definitions associated with insulation tools.

- Show students examples or illustrations of appropriate terms.

- Explain the importance of knowing the terms and definitions.

SUGGESTED ACTIVITIES

2. Use Information Sheet, Section II, to discuss guidelines for care and safe use of tools and equipment.
   - Demonstrate to the students how to sharpen, clean, and store tools properly.
   - Demonstrate how the quality and quantity of work increases when using the correct tools and sharp tools as compared to using the wrong tools and dull tools.
   - Explain your policy for replacement and repair of damaged tools.
   - Outline your tool-management policy for shop and job site.
3. Use Information Sheet, Section III, to discuss tools and equipment used for insulation installation.
   - Display examples of tools and equipment listed in this section of the information sheet.
   - Discuss and demonstrate the proper use of each tool.
   - Have students demonstrate proper use of the tools.
   - Allow students to handle the tools and check out the equipment.
4. Use Information Sheet, Section IV, to discuss safety, care, and use of tools and equipment in accordance with your plan of presentation.

H. Review information sheet.

I. Give test.

J. Critique test and discuss in class.

K. Reteach and retest as necessary.

L. Complete appropriate section of competency profiles.

III. Unit reference

Hendrix, Laborn J. "Bud." *Fundamentals of Carpentry*. Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1985.

INSULATION TOOLS
UNIT II

INFORMATION SHEET

I. Terms and definitions associated with insulation tools

A. **Accessories** — Objects or devices not essential in themselves but adding to the convenience or effectiveness of the tool or equipment

B. **Spray pump** — Equipment used to apply various types of spray-on thermal insulations

C. **Fiber blowing machine** — Equipment used to propel loose-fill materials from a hopper through a hose to the point of application

D. **Respirator** — Device worn over mouth and nose to protect the respiratory tract

E. **Thermal insulation** — Material used to retard the transfer of heat from inside a structure to the outside and from the outside into the structure

F. **Hopper** — Receptacle for delivering or discharging material through the hose to the point of application

II. Guidelines for care and safe use of hand tools, power tools, and equipment

A. Hand tools

1. Use the correct tool for the job
2. Inspect tools frequently to make sure they are in good condition
3. Keep tools sharp
4. Keep tools clean
5. Repair broken or damaged tools promptly
6. Dispose of broken or damaged tools that cannot be repaired
7. Store tools properly when not in use

EXAMPLES: Do not carry tools in your pockets; do not place tools where they can roll off; protect cutting edges; lightly oil tools before storing; store tools in dry place.

8. Stay alert when using tools
9. Wear eye protection and respirator when necessary

B. Power tools and equipment

1. Keep tools clean and in good working condition

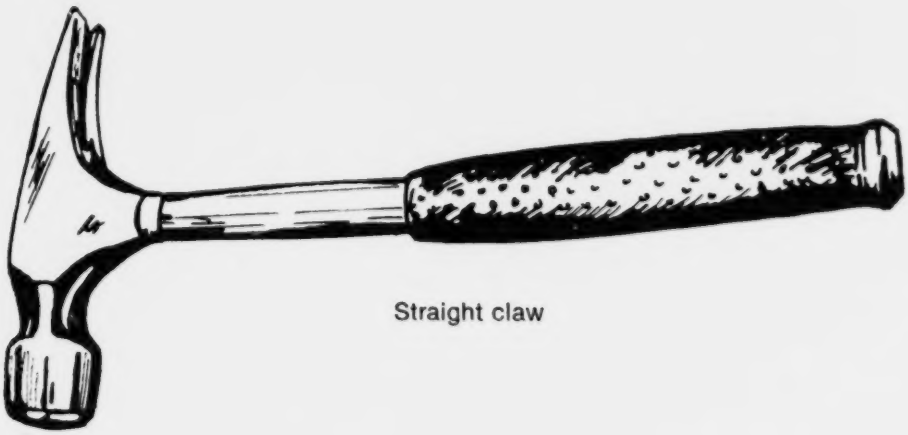
INFORMATION SHEET

2. Protect cutting edges
3. Follow manufacturer's maintenance procedure
4. Keep accessories such as blades and bits sharp
5. Keep accessories such as hoses, nozzles, jets, and agitators clean
6. Keep hoppers and mixing chambers clean
7. Inspect tools, equipment, and accessories regularly
8. Use caution when attaching a fastener to air supply
9. Keep hands and body away from discharge end of fastener
10. Never point fasteners at anyone
11. Use pressure specified by manufacturer
12. Do not remove safety devices from tools and equipment
13. Report any unusual noises, sounds, or vibrations to the instructor or supervisor
14. Check condition of all equipment before using; always mark damaged equipment and inform your instructor or supervisor

III. Tools and equipment used for insulation installation (Figures 1 and 2)

A. Claw hammer

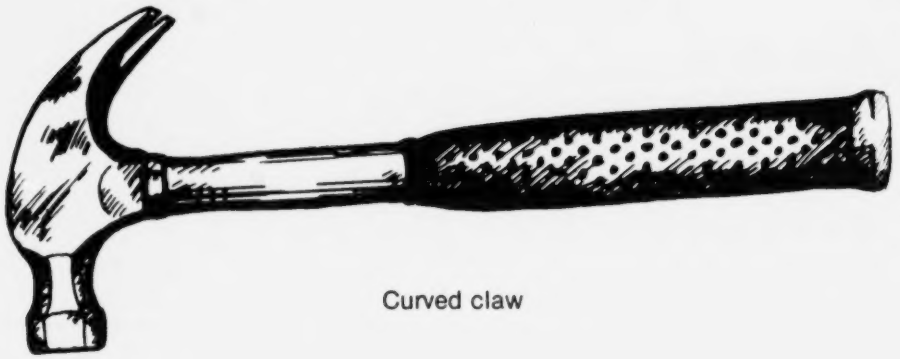
FIGURE 1



Straight claw

INFORMATION SHEET

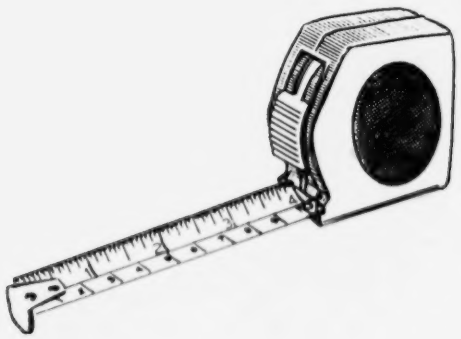
FIGURE 2



Curved claw

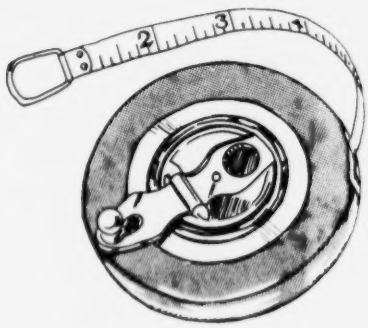
B. Measuring devices (Figures 3-5)

FIGURE 3



Steel tape

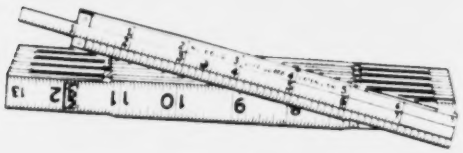
FIGURE 4



100-foot tape

INFORMATION SHEET

FIGURE 5



Folding rule

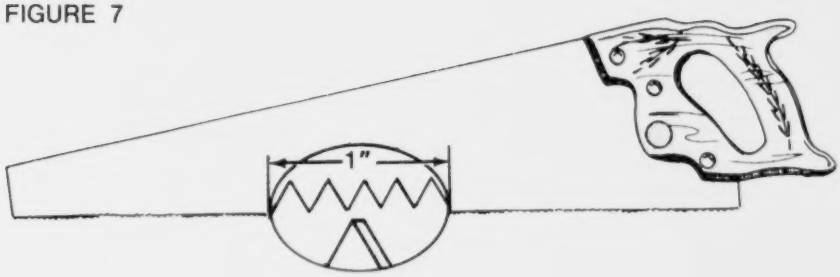
C. Framing square (Figure 6)

FIGURE 6

INFORMATION SHEET

D. Saws (Figures 7-9)

FIGURE 7

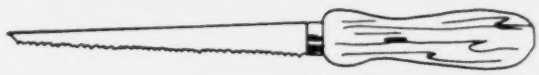


Ripsaw

FIGURE 8

Compass saw

FIGURE 9



Wallboard saw

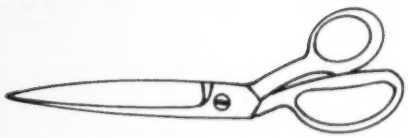
INFORMATION SHEET

E. Cutting devices (Figures 10 and 11)

FIGURE 10

Utility knife

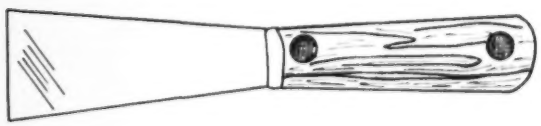
FIGURE 11



Shears

F. Putty knife (Figure 12)

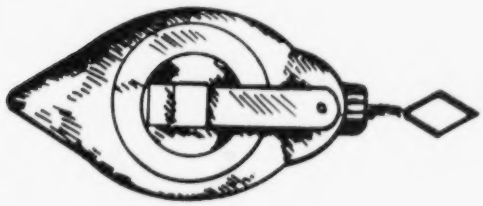
FIGURE 12



INFORMATION SHEET

G. Chalk box and line (Figure 13)

FIGURE 13

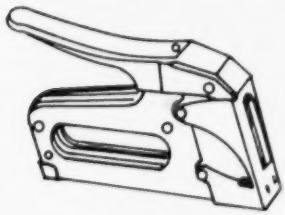


H. Straightedge (Figure 14)

FIGURE 14

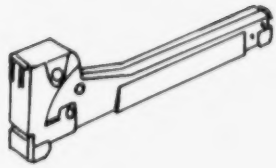
I. Fasteners (Figures 15-18)

FIGURE 15



Staple gun

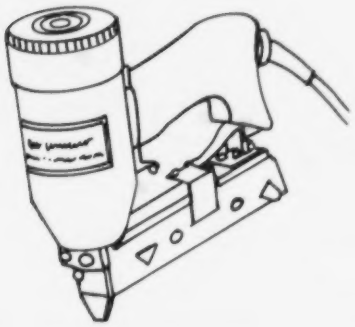
FIGURE 16



Hammer stapler

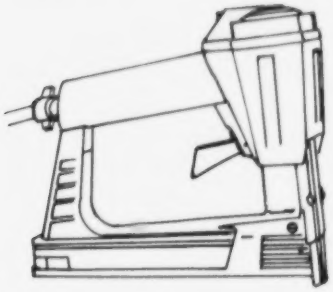
INFORMATION SHEET

FIGURE 17



Electric stapler

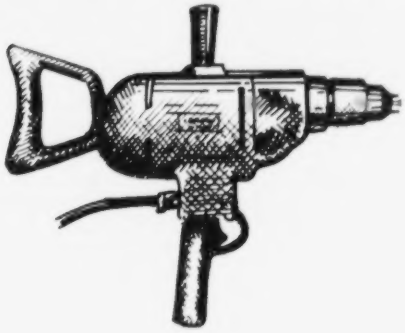
FIGURE 18



Pneumatic stapler

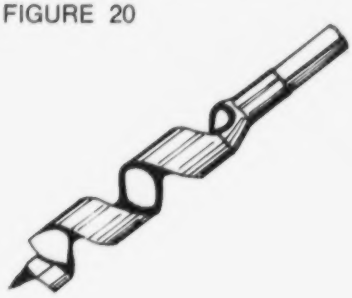
J. Electric drill (Figure 19)

FIGURE 19



K. Wood bit (Figure 20)

FIGURE 20



INFORMATION SHEET

L. Masonry bit (Figure 21)

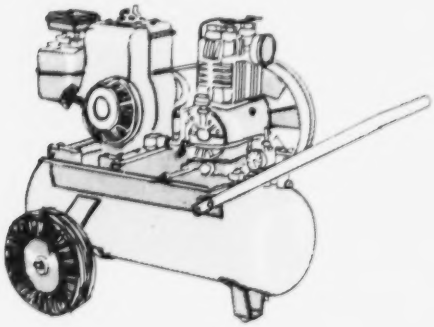
FIGURE 21

M. Caulking gun (Figure 22)

FIGURE 22

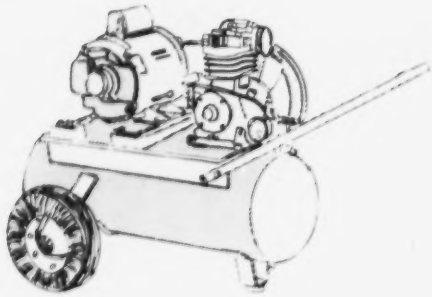
N. Air compressors (Figures 23-25)

FIGURE 23



Gasoline

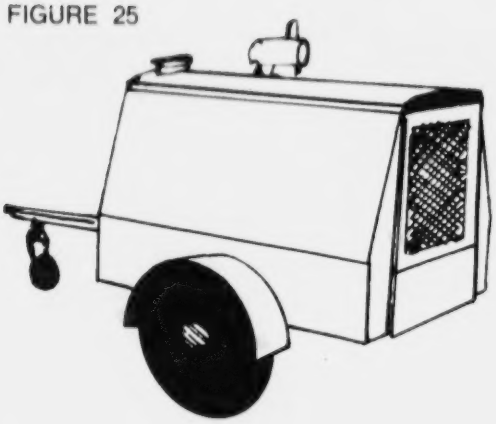
FIGURE 24



Electric

INFORMATION SHEET

FIGURE 25



Heavy duty

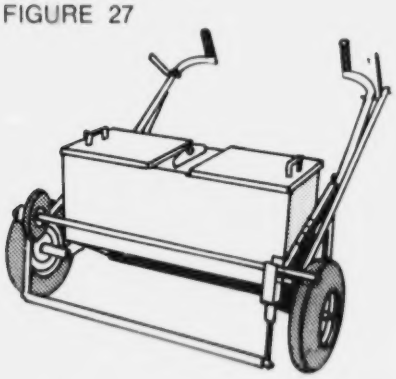
O. Mastic brush (Figure 26)

FIGURE 26

INFORMATION SHEET

P. Felt layer (Figure 27)

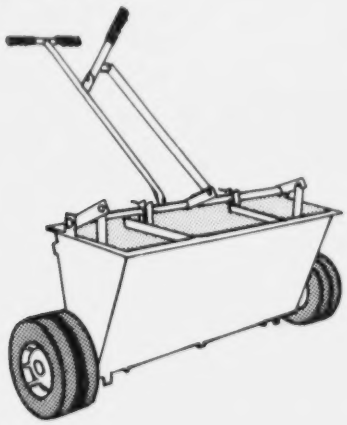
FIGURE 27



Used with permission of Reeves Roofing Equipment Co., Inc., San Antonio, Texas

Q. Adhesive dispenser (Figure 28)

FIGURE 28

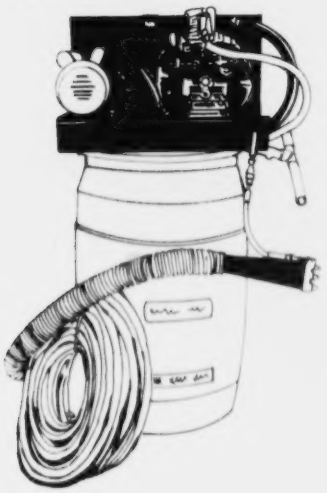


Used with permission of Reeves Roofing Equipment Co., Inc., San Antonio, Texas

INFORMATION SHEET

R. Spray pump system (Figure 29)

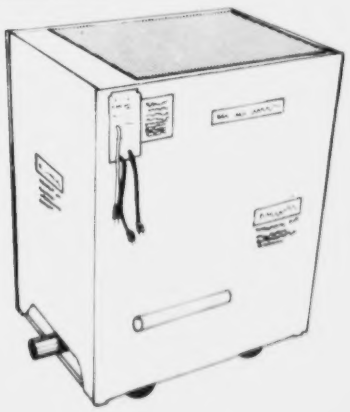
FIGURE 29



Used with permission of Enersaver Products, Inc., Denver, Colorado

S. Fiber blowing machine (Figure 30)

FIGURE 30



Used with permission of Enersaver Products, Inc., Denver, Colorado

IV. Safety rules pertaining to insulation and insulation equipment

A. Always wear eye protection and hard hat when operating power tools and equipment

B. Wear respirator when appropriate

INFORMATION SHEET

C. Wear appropriate clothing for job being done

(NOTE: Always wear tight-fitting clothing that cannot become caught in the moving tool; roll up long sleeves, tuck in shirt tails, and tie back long hair.)

D. Do not attempt to operate any tool or piece of equipment before getting approval of instructor or supervisor on that particular machine

E. Do not leave power tool or equipment running unattended

F. Do not distract others or let anyone distract you while operating tools and equipment

G. Be sure all power equipment is properly grounded

H. Be sure that power is disconnected before performing maintenance or changing accessories on equipment

I. Do not use power tools or equipment without guards or safety devices

J. Do not operate power tools if hands or feet are wet

K. Use electric extension cords of sufficient size to service tool or equipment you are using

INSULATION TOOLS
UNIT II

TEST

NAME _____ SCORE _____

1. Match terms associated with insulation tools to their correct definitions. Write the correct numbers in the blanks.

_____a. Objects or devices not essential in themselves but adding to the convenience or effectiveness of the tool or equipment

_____b. Equipment used to apply various types of spray-on thermal insulations

_____c. Equipment used to propel loose-fill materials from hopper through a hose to the point of application

_____d. Device worn over mouth and nose to protect the respiratory tract

_____e. Material used to retard the transfer of heat from inside a structure to the outside and from the outside into the structure

_____f. Receptacle for delivering or discharging material through the hose to the point of application

1. Spray pump
2. Thermal insulation
3. Accessories
4. Fiber blowing machine
5. Hopper
6. Respirator

2. State five guidelines for care and safe use of hand tools and seven guidelines for power tools and equipment

a. Hand tools

1) _____

2) _____

3) _____

4) _____

5) _____

TEST

b. Power tools and equipment

1) _____

2) _____

3) _____

4) _____

5) _____

6) _____

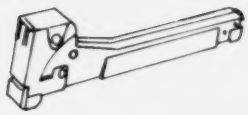
7) _____

3. Identify the following illustrations of tools and equipment used for insulation installation. Write the correct names in the blanks.

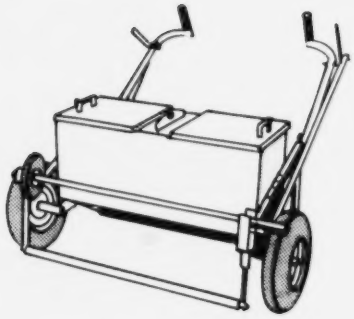
Straight claw hammer
Curved claw hammer
Wallboard saw
Chalk box and line
Pneumatic stapler
Hammer stapler
Adhesive dispenser
Spray pump system
Straightedge
Electric drill
Electric air compressor
Ripsaw
Compass saw
Steel tape
Shears
Wood bit
Mastic brush
Gasoline air compressor
Utility knife
Putty knife
Fiber blowing machine
Framing square
100-foot tape
Folding rule
Staple gun
Masonry bit
Felt layer
Caulking gun
Heavy duty air compressor
Electric stapler

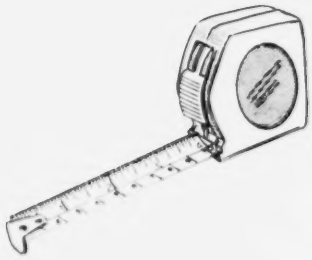
a. _____ b. _____

TEST

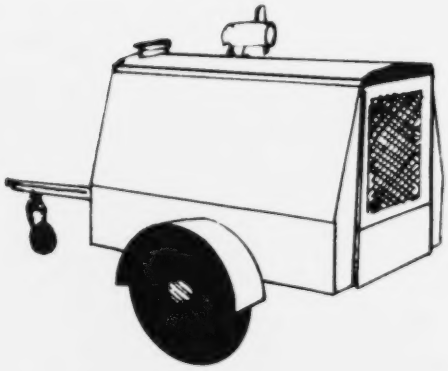


c. _____ d. _____



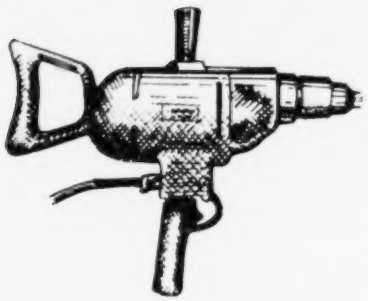


e. _____ f. _____

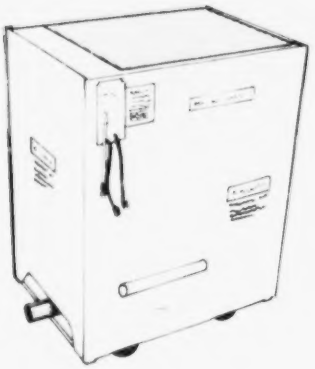


g. _____ h. _____

TEST



i. _____



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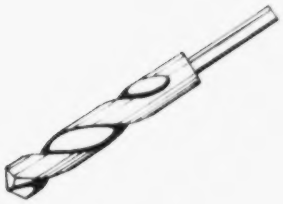
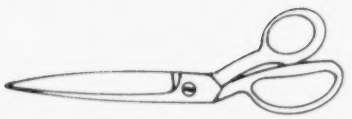
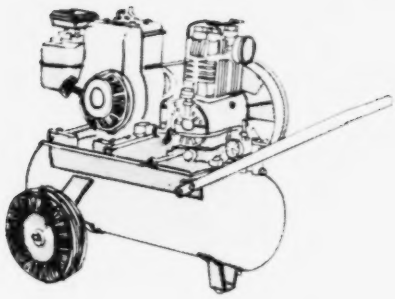


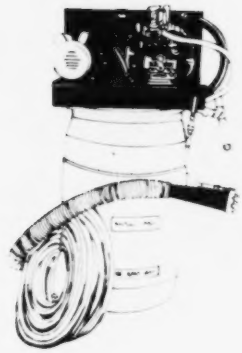


l. _____

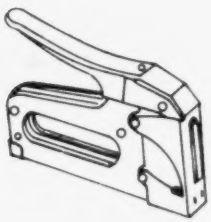
m. _____

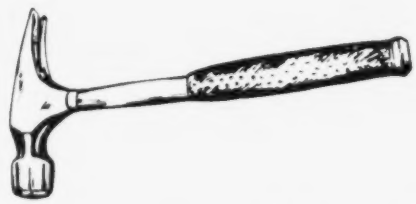
TEST



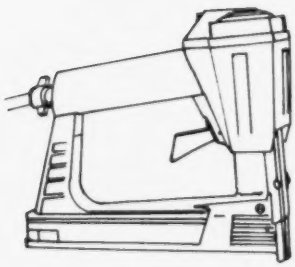


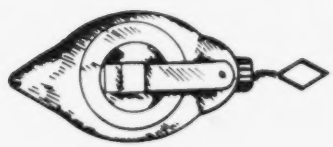
n. _____ o. _____





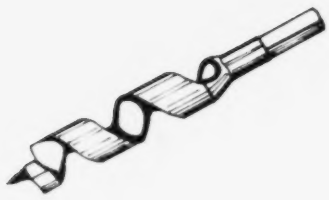
p. _____ q. _____



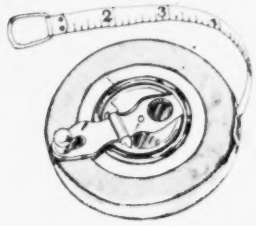


r. _____ s. _____

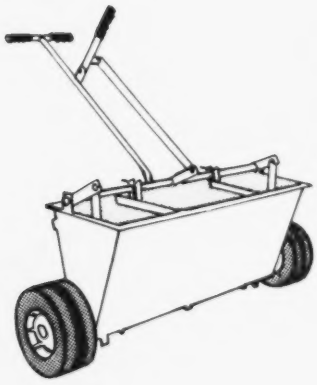
TEST



t. _____ u. _____

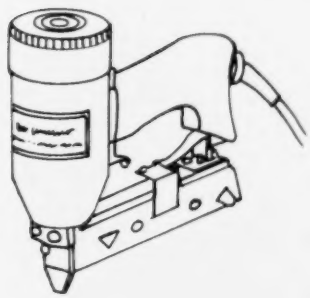


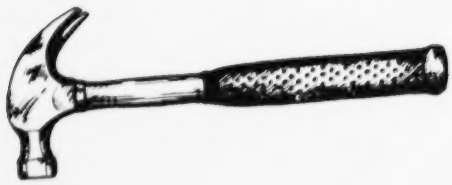
v. _____ w. _____



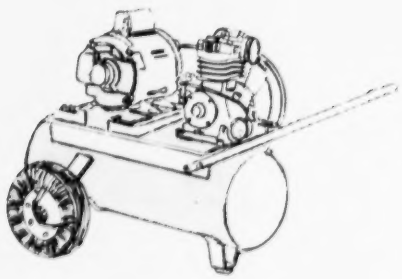
x. _____ y. _____

TEST





z. _____ aa. _____



bb. _____ cc. _____

dd. _____

TEST

4. State six safety rules pertaining to insulation and insulation equipment.

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

e. _____

_____

f. _____

_____

INSULATION TOOLS
UNIT II

ANSWERS TO TEST

1. a. 3 c. 4 e. 2
   b. 1 d. 6 f. 5

2. a. Hand tools — Answers should include any five of the following.
   1) Use the correct tool for the job
   2) Inspect tools frequently to make sure they are in good condition
   3) Keep tools sharp
   4) Keep tools clean
   5) Repair broken or damaged tools promptly
   6) Dispose of broken or damaged tools that cannot be repaired
   7) Store tools properly when not in use
   8) Stay alert when using tools
   9) Wear eye protection and respirator when necessary

   b. Power tools and equipment — Answers should include any seven of the following.
   1) Keep tools clean and in good working condition
   2) Protect cutting edges
   3) Follow manufacturer's maintenance procedures
   4) Keep accessories such as blades and bits sharp
   5) Keep accessories such as hoses, nozzles, jets, and agitators clean
   6) Keep hoppers and mixing chambers clean
   7) Inspect tools, equipment, and accessories regularly
   8) Use caution when attaching a fastener to air supply
   9) Keep hands and body away from discharge end of fastener
   10) Never point fasteners at anyone
   11) Use pressure specified by manufacturer
   12) Do not remove safety devices from tools and equipment
   13) Report any unusual noises, sounds, or vibrations to the instructor or supervisor
   14) Check condition of all equipment before using; always mark damaged equipment and inform your instructor or supervisor

3. a. Utility knife
   b. Wallboard saw
   c. Hammer stapler
   d. Straightedge
   e. Felt layer
   f. Steel tape
   g. Heavy duty air compressor
   h. Framing square
   i. Electric drill
   j. Folding rule
   k. Fiber blowing machine
   l. Masonry bit
   m. Shears
   n. Gasoline air compressor
   o. Spray pump system
   p. Staple gun
   q. Straight claw hammer
   r. Pneumatic stapler
   s. Chalk box and line
   t. Putty knife
   u. Wood bit
   v. Mastic brush

ANSWERS TO TEST

w. 100-foot tape
x. Adhesive dispenser
y. Compass saw
z. Electric stapler
aa. Curved claw hammer
bb. Ripsaw
cc. Electric air compressor
dd. Caulking gun

4. Answer should include any six of the following.

a. Always wear eye protection and hard hat when operating power tools and equipment
b. Wear respirator when appropriate
c. Wear appropriate clothing for job being done
d. Do not attempt to operate any tool or piece of equipment before getting approval of instructor or supervisor on that particular machine
e. Do not leave power tool or equipment running unattended
f. Do not distract others or let anyone distract you while operating tools and equipment
g. Be sure all power equipment is properly grounded
h. Be sure that power is disconnected before performing maintenance or changing accessories on equipment
i. Do not use power tools or equipment without guards or safety devices
j. Do not operate power tools if hands or feet are wet
k. Use electric extension cords of sufficient size to service tool or equipment you are using

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to discuss objectives, heat transfer, and physical properties of insulation. The student should also be able to list methods used to install insulation and should be able to install a vapor barrier and insulation. The students will show this knowledge by completing the job sheets and unit test with a minimum score of 80 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with layout and basic skills to their correct definitions.
2. List basic objectives of insulation.
3. List ways insulation slows heat transfer.
4. List factors that determine insulation selection.
5. Match physical properties of insulation to their correct meanings.
6. List areas where insulation should be used in construction.
7. Name factors that determine the amount of insulation needed for walls, ceilings, and floors.
8. Discuss briefly composite board roof insulation.
9. Select true statements concerning urethane foam spray insulation.
10. Select from a list methods used to apply insulation and vapor barriers.
11. State special precautions for insulation on a steel deck.
12. Demonstrate the ability to
    a. Install vapor barrier and insulation for a concrete slab.
    b. Install blanket insulation in walls.

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Supplements
  1. Supplement #1 — Average Low Temperatures in the United States
  2. Supplement #2 — R-Values per Inch for Various Types of Insulation and Construction Materials
  3. Supplement #3 — Insulation R-Values Required to Meet Comfort Standards
- D. Transparency masters
  1. TM #1 — Installation Methods
  2. TM #2 — Installation Methods (Continued)
  3. TM #3 — Installation Methods (Continued)
- E. Information sheet
- F. Job sheets
  1. Job Sheet #1 — Install Vapor Barrier and Insulation for a Concrete Slab
  2. Job Sheet #2 — Install Blanket Insulation in Walls
- I. Test
- J. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.
- B. Obtain materials to supplement unit.
  1. Earplugs, thermometers, and a safe heat source
  2. Literature and advertisements from insulation companies or public utilities

SUGGESTED ACTIVITIES

3. Model or cross-section of wall showing insulation

4. Plans specifying insulation

5. Transparency masters and competency profiles

   (NOTE: A master of the competency profile for this book is provided at the front of the instructor edition. You may duplicate the profile and distribute it to students as needed.)

C. Introduce unit to students. (If the following activities were not used to introduce Unit I, use them to introduce this unit.)

   - Demonstrate the effectiveness of insulation in sound- and heat-transfer reduction with simple examples such as earplugs, thermometer near a heat source compared to a thermometer protected by thermal insulation, etc.

   - Discuss common uses of insulation outside construction, such as in water heaters, in refrigerators, and under the hoods of cars. Emphasize that these materials insulate against sound as well as heat.

   - Display literature and advertisements from insulation companies or public utilities promoting the use of insulation.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

   1. Use Information Sheet, Section I, to discuss terms associated with insulation layout and basic skills.

      - Point out the importance of defining terms for common understanding.

      - Have students review the terms and definitions.

   2. Use Information Sheet, Section II, to discuss basic objectives of insulation.

      - Discuss the importance of using insulation to reduce noise, to retain heat and cool air, and, in the long run, to save money.

      - Exhibit samples of both thermal and acoustical insulation.

      - Provide the class with plans specifying each type of insulation and discuss their applications.

SUGGESTED ACTIVITIES

3. Use Information Sheet, Section III, to discuss the ways insulation slows heat transfer.

   - Ask the students to read articles or literature from insulation manufacturers and distributors to expand the discussion.
   - Demonstrate the benefits listed in this section of the information sheet. Use a piece of Styrofoam to point out the small interconnecting cells manufactured into it.

4. Use Information Sheet, Sections IV and V, to discuss physical properties of insulation and factors that determine insulation selection.

   - Provide the class with plans specifying each type of insulation.
   - Show the class samples of each type of insulation specified on the plans; compare cost and ease of application.
   - Have an insulation contractor or representative from an insulation manufacturing company visit with the class to discuss costs of various types of insulation, application procedures, and physical properties of insulation.

5. Use Information Sheet, Section VI, to discuss areas where insulation should be used in construction.

   - Take the class to construction sites to show them where insulation is used. Have each student make a list of the places where insulation was used.
   - Emphasize the need for insulation at any location where heat exchange is likely, and demonstrate air leaks at windows, outlets, etc. Have students re-evaluate the lists they made at the job site and add to their lists if necessary.

6. Use Information Sheet, Section VII, to discuss factors that determine the amount of insulation needed for walls, ceilings, and floors.

   - Demonstrate how the three factors discussed in this section of the information sheet are interrelated.
   - Show the class Supplements #1, #2, and #3 to relate temperature and comfort levels to insulation requirements. (Supplement #2 was also used in Unit I.)
   - Have students or groups of students ask a utility company or other agency to perform an energy audit of their homes; each student should then prepare a report comparing the results of the energy audit to the cost of the fuel saved and the cost of insulation.

- Have an insulation installer talk to the class and compare the costs of insulating new construction to insulating an existing structure.

7. Use Information Sheet, Section VIII and IX, to discuss composite board and urethane foam insulation.

   - Explain how both these types are relatively new but have become very popular in the industry because of their insulating qualities and speed of application.

   - Emphasize the importance of wearing safety equipment when working with both of these types of material.

8. Use Information Sheet, Section X, and Transparencies #1, #2, and #3 to discuss methods used to apply insulation and vapor barriers.

   - Demonstrate each method discussed in this section of the information sheet and relate each method to specific types of insulation.

   - Demonstrate the procedures in Job Sheets #1 and #2.

   - Have the students complete Job Sheets #1 and #2.

9. Use Information Sheet, Section XI, to discuss the special precautions that should be used when insulating steel decks.

   - Explain the importance of properly installed insulation on fluted steel decks.

   - Point out to the students that if the insulation does not span the flutes, walking on it would break it down in the voids. For this reason, thicker insulation must be used when the flutes are wider.

   - Discuss how using specially designed insulation would solve a lot of the above problems.

H. Give test.

I. Critique test and discuss in class.

J. Reteach and retest as necessary.

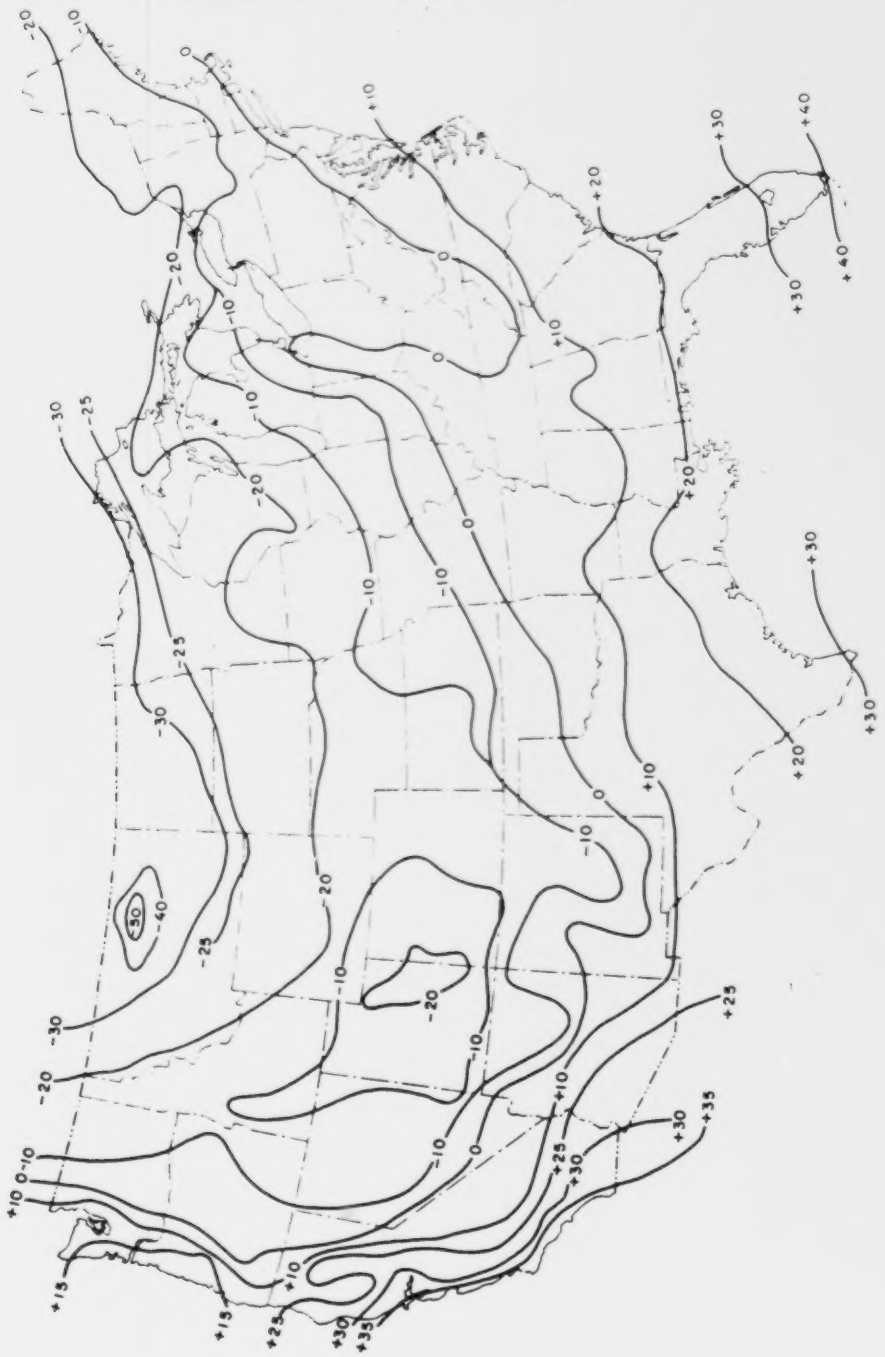
K. Complete appropriate sections of competency profiles.

III. Unit reference

Hendrix, Laborn J. "Bud." *Commerical Carpentry* — Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1986.

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

SUPPLEMENT #1 — AVERAGE LOW TEMPERATURES IN THE UNITED STATES (Climate Zones)



INSULATION LAYOUT AND BASIC SKILLS
UNIT III

SUPPLEMENT #2 — R-VALUES PER INCH FOR VARIOUS TYPES OF INSULATION AND CONSTRUCTION MATERIALS

Material	R-Value per Inch
Polyisocyanurate	7.2
Extruded styrene	5.2
Fiberglass board	4.7
Expanded polystyrene	4.0
Cellulose	3.8
Corkboard	3.7
Fiberglass (batts)	3.2
Rock wool	3.0
Perlite (expanded)	3.1
Fiberglass loose fill (premium grade)	2.7
Fiberglass loose fill (standard grade)	2.2
Cellular glass	2.6
Vermiculite (loose fill)	2.0
Fir, pine	1.3
Concrete block	1.1
Glass	0.9
Brick	0.2
Cement plaster	0.2

(NOTE: Fiberglass loose fill has a wide range of R/inch values depending on brands.)

SUPPLEMENT #2

(NOTE: K-Factor — The amount of heat (in Btu's) transferred in one hour through 1 square foot of a given material that is 1 inch thick and has a temperature difference between its surfaces of 1 degree Fahrenheit (F). It is also called the coefficient of thermal conductivity.

R-Value — Represents the resistivity or resistance which is the reciprocal of conductivity or conductance. A good insulation material will have a high R-Value.

U-Value — Represents the total heat transmission (in Btu's) per square foot, per hour with 1 degree temperature difference for a structure which may consist of several materials or spaces. A good insulation material will have a low U-Value.)

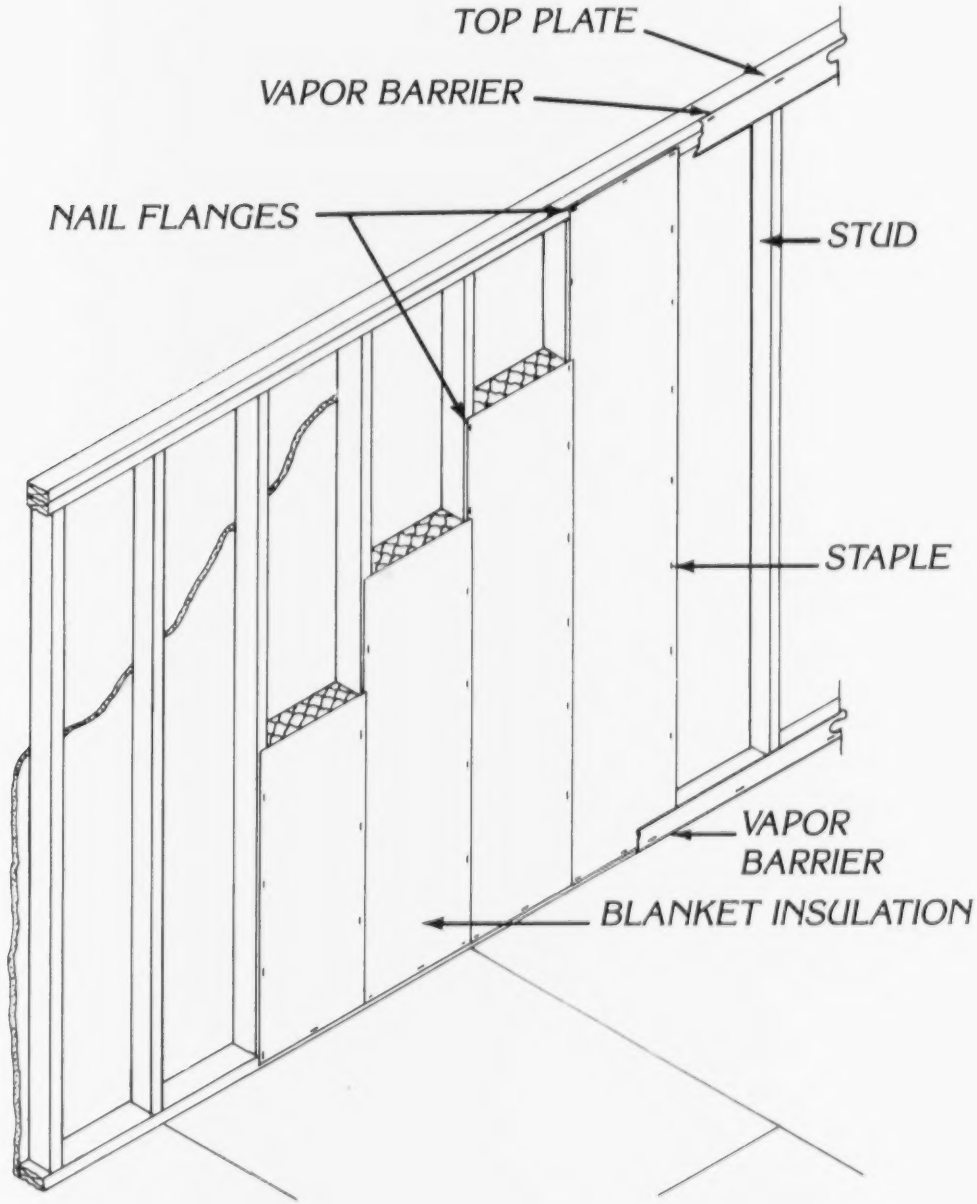
INSULATION LAYOUT AND BASIC SKILLS
UNIT III

SUPPLEMENT #3 — INSULATION R-VALUES REQUIRED TO MEET COMFORT STANDARDS

Standard	Insulation Location	Insulation R-Value
For all-weather comfort	Walls	R 19
	Ceilings	R 30
	Floors	R 19
For moderate comfort	Walls	R 13
	Ceilings	R 26
	Floors	R 13
For minimum comfort	Walls	R 11
	Ceilings	R 19
	Floor	R 11

Installation Methods

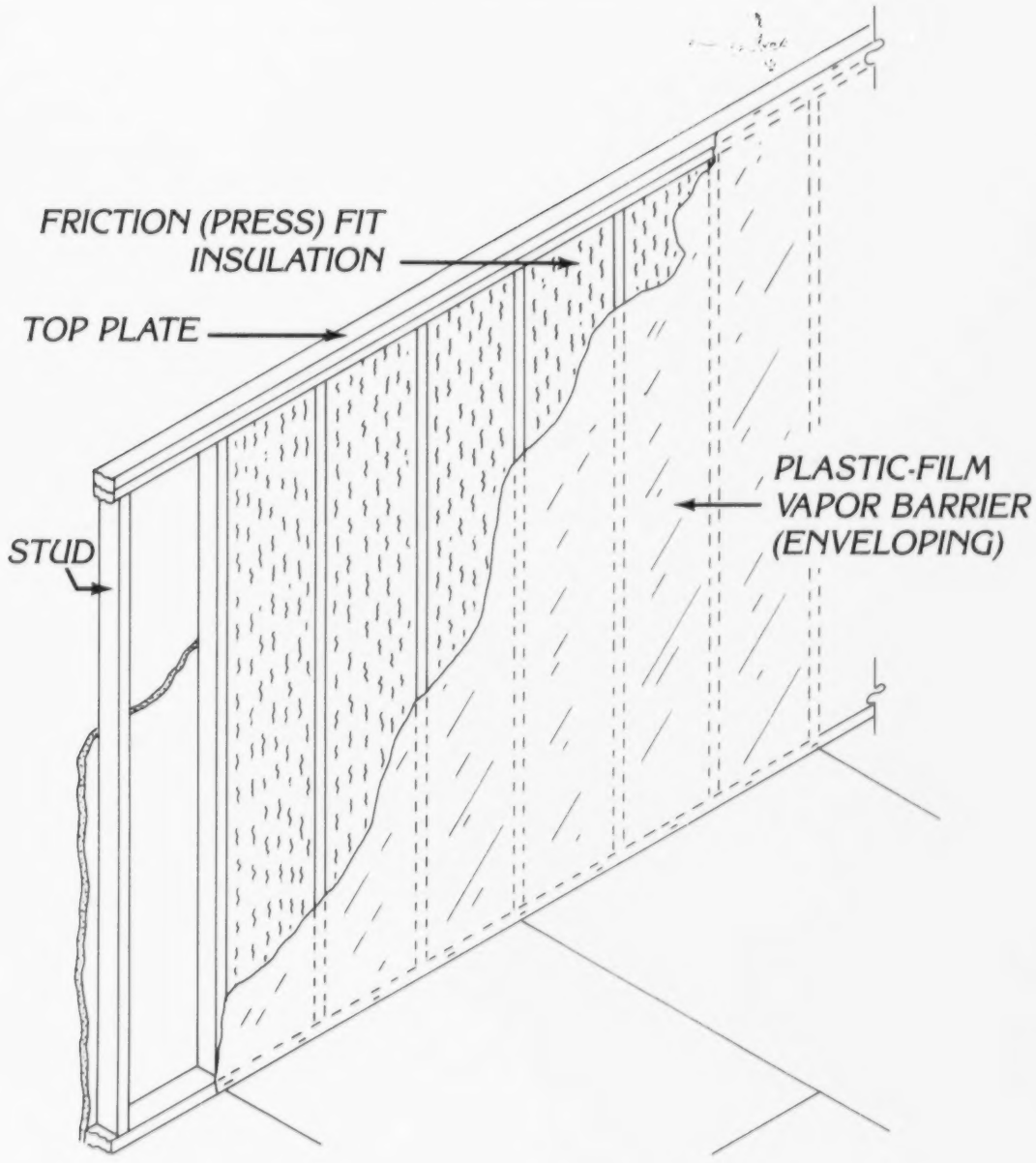
(NOTE: Tabs or nail flanges may be attached to face or sides of studs.)



WALL SECTION WITH BLANKET INSULATION

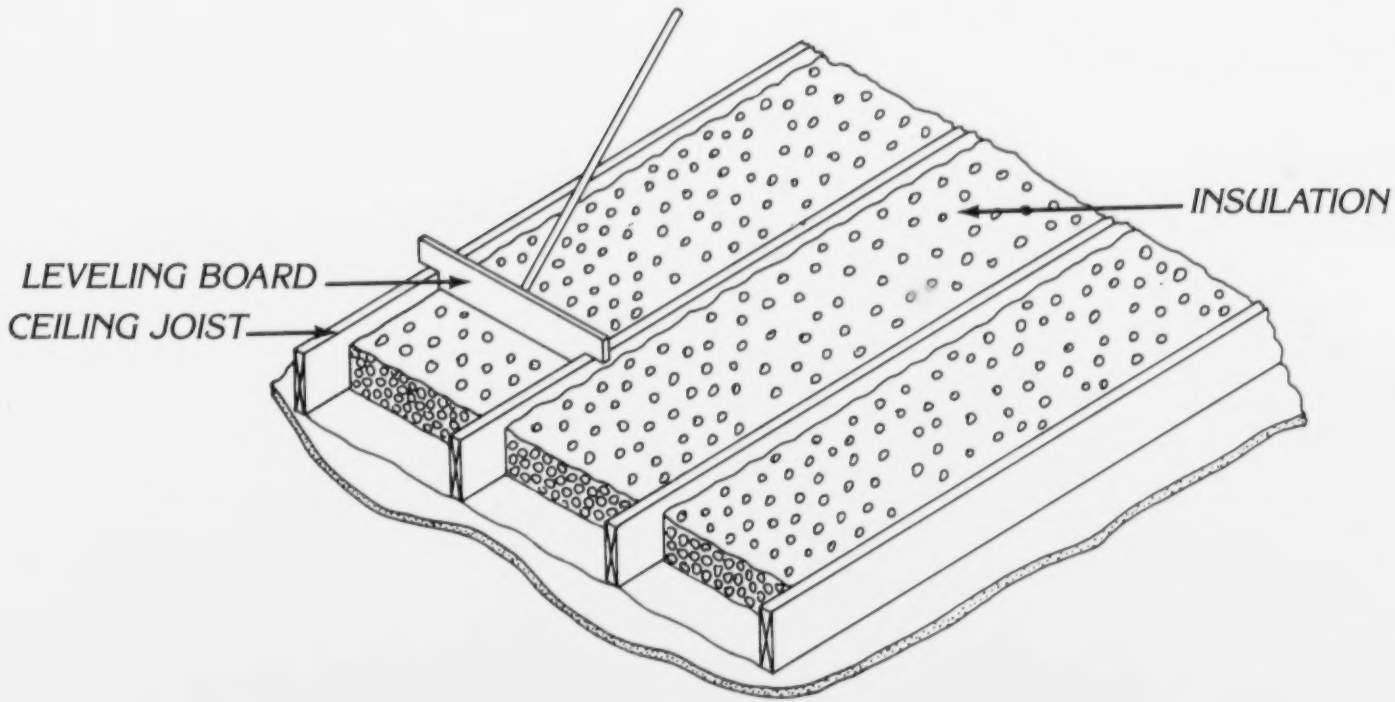
Installation Methods

(Continued)



WALL SECTION
WITH FRICTION (PRESS) FIT INSULATION

Installation Methods
(Continued)



CEILING WITH FULL INSULATION

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

INFORMATION SHEET

I. Terms and definitions associated with layout and basic skills

A. **Acoustic barrier** — Material used to diminish the flow of sound from one area to another

B. **Factory Mutual (FM)** -- An organization that classifies roof assemblies for their fire characteristics and wind-uplift resistance for insurance companies in the United States

C. **Underwriters Laboratories (UL)** — An organization that classifies assemblies for their fire characteristics for insurance companies in the United States

D. **Life-cycle cost** — Extension of cost/benefit ratios over the life of a structure

(NOTE: Its premise in the roofing industry is that added initial costs can substantially reduce lifetime operating costs in relation to energy expended for heating and cooling.)

E. **Expansion** — The natural tendency of a system or material to expand because of warm weather and the resulting movement of a system

F. **Contraction** — The natural tendency of a system to contract because of cold weather and the resulting movement of a system

G. **Substrate** — Any component in a built-up roof that lies beneath another surface

H. **Toxic fumes** — Poisonous gas

I. **K-Factor** — Amount of heat (in Btu's) transferred in one hour through one square foot of a given material that is one inch thick and has a temperature difference between its surfaces of one degree Fahrenheit

J. **R-Value** — The resistance which is the reciprocal of conductivity or conductance

K. **Btu** — Abbreviation for British thermal unit and is the amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit

II. Basic objectives of insulation

A. To conserve vital energy by moderating heat transfer into and out of a structure

B. To reduce life-cycle operating costs of a structure

C. To create an improved environment in the interior of a structure

INFORMATION SHEET

D. To provide an acoustic barrier from within and without

E. To improve the fire resistant qualities of a structure in accordance with FM and UL classifications

F. To reduce the potential for wind-uplift damage to a roof system in accordance with FM and UL classifications

(NOTE: The energy crisis has resulted in the emergence of insulation as the most important element in built-up roofing; in the past it was frequently ignored in order to keep costs down, but it is now regarded as the most important factor in reducing costs over the life cycle of a structure.)

III. Ways insulation slows heat transfer

A. Specifically designed thicknesses

(NOTE: The thickness of a material determines the rate of heat transfer through the material.)

B. Designed obstructions within materials

(NOTE: Obstructions are in the form of numerous spaces or voids through which heat must seek an ever-changing path and is, therefore, slowed down.)

C. Introduction of inert gases

(NOTE: Cellular glass is manufactured with millions of connected cells of inert gas designed specifically to slow heat transfer.)

D. Use of light colors to reflect heat

(NOTE: Light-colored aggregates, shingles, and coatings reflect radiant heat from the sun and help slow heat transfer.)

IV. Factors that determine insulation selection

A. Ability to reduce sound and thermal transmission

B. Cost

C. Ease of application

D. Fire resistant qualities

(NOTE: Insulation materials are tested for fire resistant qualities and these ratings become a part of the insulation specifications and eventually affect a building owner's insurance costs.)

INFORMATION SHEET

E. Wind-uplift characteristics

(NOTE: Insulation materials must meet application standards designed to withstand wind-uplift and these standards become part of the insulation specifications.)

V. Physical properties of insulation and their meanings

A. **Permeance** — An index of a material's resistance to water vapor transmission

EXAMPLE: The lower the perm rating, the higher the insulation's resistance to water vapor transmission; an insulation rate at 1 perm would theoretically be better than one rated at 2 perm, 3 perm, etc.

B. **Thermal shock resistance** — The ability of an insulation to withstand rapid temperature changes without physical failure

C. **Compressive strength** — The ability of an insulation to resist a load force that tends to squeeze or shorten it

D. **Tensile strength** — The ability of an insulation to resist a stress load that tends to pull it apart

E. **Shear strength** — The ability of an insulation to resist splitting

F. **Dimensional stability** — The ability of an insulation to retain its length, width, and thickness during and after the rigors of application, and its continued ability to tolerate expansion and contraction without deterioration of stability or insulating qualities

VI. Areas where insulation should be used in construction

(NOTE: In general, insulation should be used where any structural surface is exposed to thermal exchange.)

A. Over the ground in crawl space

B. Around perimeter of concrete floors and foundations

C. Between floor joists

D. Between wall studs

E. Above ceilings

F. In frame roof structures

(NOTE: In the roof structure, the vapor barrier must always face the heated area [toward interior]. For proper air circulation, the air space must always be maintained between the insulation and the roof sheathing.)

G. On top of flat and built-up roofs

H. Between exterior structural members and the exterior finish

VII. Factors that determine the amount of insulation needed for walls, ceilings, and floors

A. Average low and high temperatures

(NOTE: Although the average low temperature is normally used as the basis for determining insulation requirements, the average high temperature of an area should also be considered in warm climates to prevent loss of cool inside air and penetration of hot outside air.)

B. Level of comfort desired

(NOTE: Comfort level refers to the inside temperature that must be maintained for personal comfort. Comfort levels are generally divided into three standards: the all-weather standard, the moderate standard, and the minimum standard. To meet the all-weather standard, the amount of insulation provided must be adequate to maintain a desired temperature even during periods of extreme outside temperatures. To meet the moderate standard, the insulation provided must be adequate to maintain a desired temperature during the periods of average outside temperature extremes. And, to meet the minimum standard, the amount of insulation provided must only be adequate enough to reduce heat exchange.)

C. Cost

(NOTE: When determining the amount of insulation needed, compare the insulation cost to the cost of fuel needed to maintain a given comfort level; also include in your comparison the cost of materials and labor and the interest paid on the increased cost. Ensure that the cost of the insulation will pay for itself in terms of all these expenses.)

VIII. Composite board roof insulation

A. Composite board roof insulation is typically constructed of a bottom layer of perlite, mineral fiber, or glass fiberboard laminated to a center core of polyurethane and top surfaced with asphalt roofing felt or fibrous glass material.

CAUTION

To avoid breathing particles, wear a dust mask when working with composite board.

B. Relatively new to the roofing industry, composite board insulation is particularly suited to steel deck applications because it provides both the substrate and insulating qualities to assure that components and the assembly will not directly contribute to the initial spread of fire under a steel deck.

C. Construction design eliminates the need for multiple applications.

INFORMATION SHEET

IX. Urethane foam spray insulation

(NOTE: Because of the energy crisis and resulting insulation supply shortages, urethane foam spray insulation has emerged to take a prominent place in insulation.)

A. Workers who handle urethane foam spray should be trained in application techniques and safety measures, such as wearing a respirator to minimize the dangers of toxic fumes.

B. Because it can be sprayed on, urethane foam readily adheres to roof contours.

C. Application time is fast compared to conventional hand or machine applications of insulation.

D. Urethane foam is not fire resistant and must be used in conjunction with an immediate covering of silicone spray to attain fire resistant qualities and be protected from weathering and sunlight.

E. Its light weight and K-Factor of 0.14 make urethane foam especially attractive as an insulation.

F. Basic equipment costs for the system are high.

X. Methods used to apply insulation and vapor barriers

(NOTE: Fastening and nailing patterns are specified by insulation manufacturers and by Factory Mutual.)

A. Staple

(NOTE: Insulation and vapor barriers may be stapled down with either a staple gun or a power-operated stapler.)

B. Nail

(NOTE: Either a hammer or a pneumatic fastener may be used in nailing insulation and vapor barriers.)

C. Pressed in place and held with mastic or adhesive

D. Hand pour

(NOTE: Loose-fill material is often hand poured.)

E. Blown in

(NOTE: Loose-fill material may be blown in place.)

F. Dry spray

G. Wet spray

(NOTE: Adhesive-type material is sprayed on.)

H. Rolled out and taped at joints

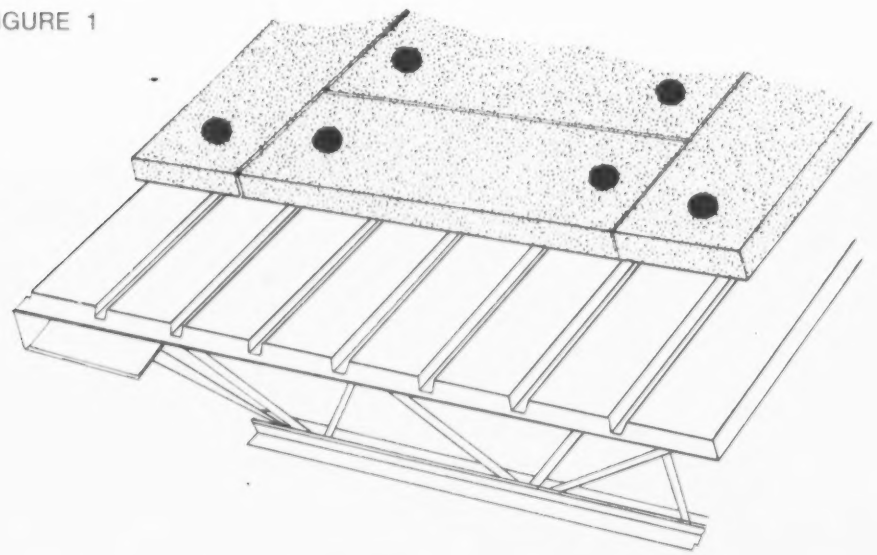
(NOTE: When polyethylene film or roll roofing is installed, the material should be lapped at least 4 inches on all edges and should extend up the walls as required. Use tape to seal all edges and to hold the material up on the walls.)

XI. Special precautions for insulation on a steel deck

A. Insulation board must completely span the flutes in a steel deck and reach as close to center of the flanges as material permits (Figure 1).

EXAMPLE:

FIGURE 1



Adapted with permission of Owens-Corning Fiberglas Corp., Toledo, Ohio.

B. The wider the flutes in a steel deck, the thicker the insulation must be to facilitate the span.

C. Many manufacturers design insulation boards in special thicknesses to span flutes of various widths; this is listed as the insulation's "flute span-ability."

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

JOB SHEET #1 — INSTALL VAPOR BARRIER AND INSULATION FOR A CONCRETE SLAB

I. Tools and materials

A. 2′ × 8″ × 1″ rigid insulation

B. Polyethylene plastic film

C. Mastic or special adhesive

D. Utility knife or shears

E. Putty knife or pointing trowel

F. Folding rule or steel tape

II. Procedure

A. Vertical insulation on foundation wall

1. Clean out along inside of foundation to a depth of 2′ – 4″ below finish-floor elevation

2. Use mastic to install rigid insulation on edge (vertically) along the inside of the two long sides of the foundation

3. Use mastic to install rigid insulation on edge along the inside of the two ends of the foundation

B. Horizontal insulation around perimeter of slab

1. Be sure that sand fill is graded to proper elevation for floor slab, then remove enough sand around the foundation's perimeter to allow for the 1-inch insulation

2. Install insulation horizontally around the inside perimeter of the foundation, lapping the pieces over the top of the vertical pieces and placing them tightly against the foundation

C. Vapor barrier installation

1. Lay a roll of plastic film at one end of the floor base and roll out film to the other end; measure this distance

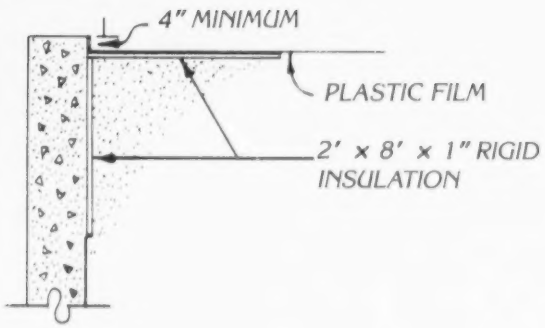
2. Add 8 inches to distance determined in step 1 and cut plastic

(NOTE: Plastic film should be extended up at least 4 inches at each foundation wall.)

3. Unfold length of plastic and lay out flat on the sand fill, allowing 4 inches to extend the film up the foundation wall at both ends and 4 inches to extend the film up the side foundation wall. (See Figure 2 on the following page.)

JOB SHEET #1

FIGURE 2



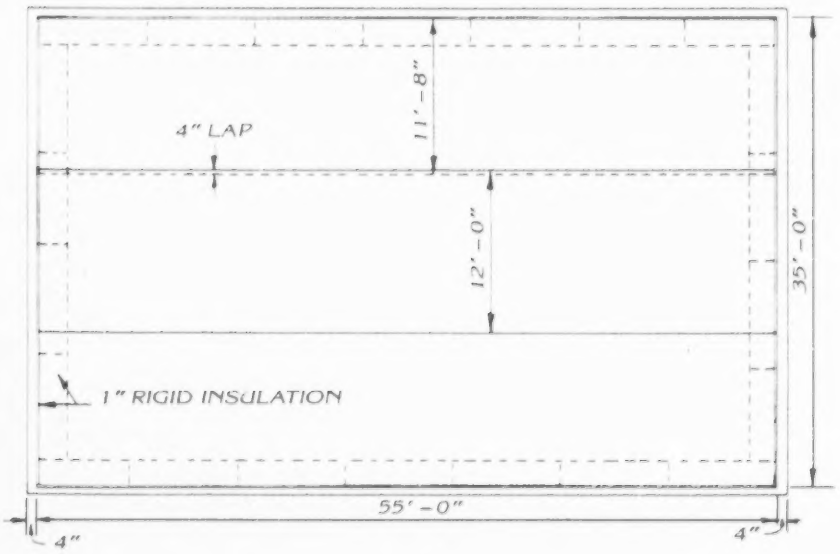
4. Roll out another piece of plastic to length determined in steps 1 and 2 and cut

5. Unfold this length and lay out on sand fill, allowing 4 inches to extend the film up the foundation wall at each end and 4 inches to lap this piece over the first piece

6. Continue following the procedures in steps 4 and 5 until entire area is covered (Figure 3)

   (NOTE: If you end up with only a narrow strip to cover, you may want to piece it in with short pieces rather than waste material)

FIGURE 3



JOB SHEET #1

7. Use mastic adhesive or tape to seal the seams where the plastic strips overlap and to hold the ends and edges up on the foundation walls

8. Clean up area and put away tools and materials

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

JOB SHEET #2 — INSTALL BLANKET INSULATION IN WALLS

I. Tools and materials

A. Utility knife or shears

B. Hand or pneumatic stapler

C. Staples

D. Tape

E. Insulation batts

F. Pencil

II. Procedure

A. Measure space to be filled with insulation, and add 2 or 3 inches to that measurement

(NOTE: Insulation should be 2 to 3 inches longer than the space to be filled; this allows enough length so that some of the batting can be removed from both ends to allow nail flanges on top and bottom.)

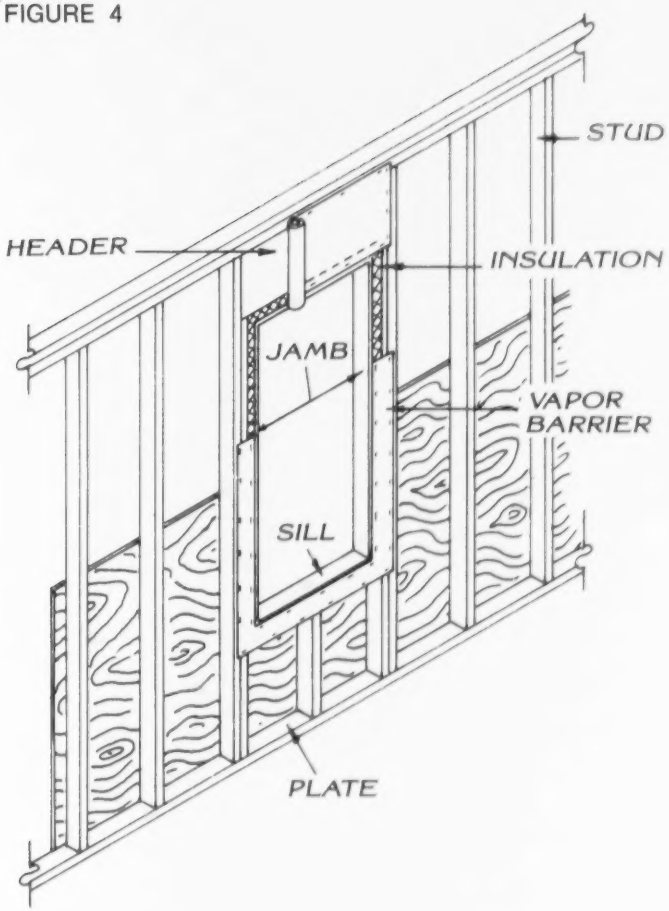
B. Mark on the floor the length determined in Step A

C. Roll out insulation between marks on floor and cut insulation to length

(NOTE: Save cut-off ends and pieces so that they may be used to fill small spaces around windows, doors, electrical boxes, and any other small openings. See Figure 4 on following page.)

JOB SHEET #2

FIGURE 4



D. Place insulation in wall opening with nail flange over top plate and side tabs over studs; carefully fit insulation around pipes, conduits, electrical boxes, window, and door frames (Figure 4)

   (NOTE: Tabs may be attached to face or sides of studs.)

E. Staple the top nail flange to top plate and then, working from top to bottom and alternating from one side to the other, staple the side tabs to the studs, placing staples no more than 12 inches apart

F. Staple bottom nail flange to plate

G. Follow procedures in steps A through F until all walls are insulated

JOB SHEET #2

H. Check to see that no openings were missed and that all the insulation is properly installed; fill these openings as necessary

I. Clean up area and put away tools and materials

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

TEST

NAME _____ SCORE _____

1. Match terms associated with layout and basic skills to their correct definitions. Write the correct numbers in the blanks.

_____a. Material used to diminish the flow of sound from one area to another

_____b. An organization that classifies roof assemblies for their fire characteristics and wind-uplift resistance for insurance companies in the United States

_____c. Extension of cost/benefit ratios over the life of a structure

_____d. The natural tendency of a system or material to expand because of warm weather and the resulting movement of a system

_____e. An organization that classifies assemblies for their fire characteristics for insurance companies in the United States

_____f. The natural tendency of a system to contract because of cold weather and the resulting movement of a system

_____g. Any component in a built-up roof that lies beneath another surface

_____h. Poisonous gas

_____i. Amount of heat transferred in one hour through one square foot of a given material that is one inch thick and has a temperature difference between its surfaces of one degree Fahrenheit

_____j. The resistance which is the reciprocal of conductivity or conductance

_____k. Amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit

1. R-Value
2. Substrate
3. Underwriter's Laboratories (UL)
4. Toxic fumes
5. Btu
6. Acoustic barrier
7. Life-cycle cost
8. K-Factor
9. Expansion
10. Contraction
11. Factory Mutual (FM)

TEST

2. List four objectives of insulation.

   a. _____

   _____

   b. _____

   _____

   c. _____

   _____

   d. _____

   _____

3. List two ways insulation slows heat transfer.

   a. _____

   b. _____

4. List three factors that determine insulation selection.

   a. _____

   b. _____

   c. _____

5. Match physical properties of insulation to their correct meanings. Write the correct numbers in the blanks.

   _____a. An index of a material's resistance to water vapor transmission

   _____b. The ability of an insulation to withstand rapid temperature changes without physical failure

   _____c. The ability of an insulation to resist load force that tends to squeeze or shorten it

   _____d. The ability of an insulation to resist a stress load that tends to pull it apart

   _____e. The ability of an insulation to resist splitting

   _____f. The ability of an insulation to retain its length, width, and thickness during and after the rigors of application and its continued ability to tolerate expansion and contraction without deterioration of stability or insulating qualities

   1. Compressive strength
   2. Dimensional stability
   3. Tensile strength
   4. Permeance
   5. Shear strength
   6. Thermal shock resistance

TEST

6. List four areas where insulation should be used in construction.

   a. _____

   b. _____

   c. _____

   d. _____

7. Name three factors that determine the amount of insulation needed for walls, ceilings, and floors.

   a. _____

   b. _____

   c. _____

8. Discuss composite board roof insulation.

   a. _____

   b. _____

   c. _____

TEST

9. Select the true statements concerning urethane foam spray insulation. Write an "X" in the blank before each correct answer.

_____a. Workers who handle urethane foam spray should be trained in application techniques and safety measures, such as wearing a respirator to minimize the dangers of toxic fumes.

_____b. Because it can be sprayed on, urethane foam readily adheres to roof contours.

_____c. Application time is slow compared to conventional hand or machine applications of insulation.

_____d. Urethane foam is not fire resistant and must be used in conjunction with an immediate covering of silicone spray to attain fire resistant qualities and be protected from weathering and sunlight.

_____e. Its light weight and K-Factor of 0.14 make urethane foam especially attractive as an insulation.

_____f. Basic equipment costs for the system are low.

10. Select the methods used to apply insulation and vapor barriers. Write an "X" in the blank before each correct answer.

_____a. Hand pour

_____b. Screw

_____c. Wet spray

_____d. Staple

_____e. Blown in

_____f. Dry spray

_____g. Rolled out and taped at joints

_____h. Nail

_____i. Friction held

_____j. Pressed in place and held with mastic or adhesive

11. State two special precautions for insulation on a steel deck.

a. _____

_____

b. _____

_____

(NOTE: Test question #12 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

12. Demonstrate the ability to

a. Install vapor barrier and insulation for a concrete slab.

b. Install blanket insulation in walls.

INSULATION LAYOUT AND BASIC SKILLS
UNIT III

ANSWERS TO TEST

1.

a. 6	d. 9	g. 2	j. 1
b. 11	e. 3	h. 4	k. 5
c. 7	f. 10	i. 8	

2. Answer should include any four of the following.

   a. To conserve vital energy by moderating heat transfer into and out of a structure
   b. To reduce life-cycle operating costs of a structure
   c. To create an improved environment in the interior of a structure
   d. To provide an acoustic barrier from within and without
   e. To improve the fire resistant qualities of a structure in accordance with FM and UL classifications
   f. To reduce the potential for wind-uplift damage to a roof system in accordance with FM and UL classifications

3. Answer should include any two of the following.

   a. Specifically designed thicknesses
   b. Designed obstructions within materials
   c. Introduction of inert gases
   d. Use of light colors to reflect heat

4. Answer should include any three of the following.

   a. Ability to reduce sound and thermal transmission
   b. Cost
   c. Ease of application
   d. Fire resistant qualities
   e. Wind-uplift characteristics

5.

a. 4	c. 1	e. 5
b. 6	d. 3	f. 2

6. Answer should include any four of the following.

   a. Over the ground in crawl space
   b. Around perimeter of concrete floors and foundations
   c. Between floor joists
   d. Between wall studs
   e. Above ceilings

ANSWERS TO TEST

f. In frame roof structures
g. On top of flat and built-up roofs
h. Between exterior structural members and the exterior finish

7. Answers should include the following.

   a. Average low and high temperatures
   b. Level of comfort desired
   c. Cost

8. Discussion should include

   a. Composite board roof insulation is typically constructed of a bottom layer of perlite, mineral fiber, or glass fiberboard laminated to a center core of polyurethane and top surfaced with asphalt roofing felt or fibrous glass material.
   b. Relatively new to the roofing industry, composite board insulation is particularly suited to steel deck applications because it provides both the substrate and insulating qualities to assure that components and the assembly will not directly contribute to the initial spread of fire under a steel deck.
   c. Construction design eliminates the need for multiple applications.

9. a, b, d, e

10. a, c, d, e, f, g, h, j

11. Answer should include any two of the following.

   a. Insulation boards must completely span the flutes in a steel deck and reach as close to center of the flanges as material permits.
   b. The wider the flutes in a steel deck, the thicker the insulation must be to facilitate the span.
   c. Many manufacturers design insulation boards in special thicknesses to span flutes of various widths; this is listed as the insulation's "flute span-ability."

12. a. Performance skills evaluated to the satisfaction of the instructor.
    b. Performance skills evaluated to the satisfaction of the instructor.